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ON THE INADVISABILITY OF SEPARATING THE GENERA MICROCOCCUS AND STAPHYLOCOCCUS

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As pointed out in the International Bulletin of Bacteriological Nomenclature and Taxonomy by the Editorial Board (1954), there seems to have been a tacit assumption by many workers that Micrococcus Cohn 1872 and Staphylococcus Rosenbach 1884 constitute two differentiable genera; but evidence to support this view appears to be entirely lacking. The attempt, initiated by the Winslows (1908), to separate the more parasitic orange and white staphylococci from the more saprophytic yellow and red micrococci has been criticized by both Hucker (1924a) and Rahn (1929b) and has been largely abandoned. Hucker (1924a), after studying a collection of 316 strains of the micrococcus-staphylococcus group, reported (p. 72) that "no correlations of characters were found that indicated that there were natural subdivisions of this group."

Although aware of the lack of evidence concerning natural subdivisions, Hucker (1924b, 1928) decided upon an arbitrary separation of the mass-forming cocci into 18 species[1] based primarily on pigmentation, gelatin liquefaction, nitrate reduction, and utilization of ammonium phosphate as sole nitrogen source. With only minor changes, this is the system adopted in the current edition of Bergey's Manual (Breed et al., 1948).

That Hucker's classification is indeed an arbitrary one has been emphasized by Rahn (1929a) who called attention to

[1]Exclusive of Micrococcus tetragenus which is now classified as Gaffkya tetragena.

the great variability of these cocci (among Hucker's 316 strains only 9 were duplicates) and pointed out the complete parallelism within the group. Rahn's tables and charts show that the various strains of micrococci can be arranged in series, each strain differing from the next by a single property, and with orange, yellow, and white parallels in almost every case. Rahn's evidence is quite convincing, as is his conclusion that, "Any division line is arbitrary whether it be called genus or species division. Really, the entire group of micrococci behaves like one species with an enormous number of different varieties the extremes of which are widely different." It would appear that the micrococcus-staphylococcus group cannot be divided into species (nor genera) on the basis of the characteristics now used in their classification.

Recently it has again been suggested that an attempt be made to separate Staphylococcus from Micrococcus, this time based upon utilization of ammonium phosphate and asparagine as sole sources of nitrogen. In this journal, the Editorial Board (1954) has suggested the same possibility and invited discussion upon this and other points. A reappraisal of Hucker's (1924a) report, the only study to date giving complete results for all strains, reveals that such a separation is unwise.

Hucker's 316 strains vary in Gram-reaction, but nearly all show some tendency to be Gram-positive. In addition, they are all alike in cell form, size, and arrangement; in failure to produce spores or flagella, or to form indole; and in being aerobic to facultative. They vary in the other properties recorded, and a large number of the possible varieties are found among the 316 strains. However, none of these is represented by a large enough number of strains to permit much comparison except for the most common type represented by 136 strains all showing the following properties:

Hemolysis (blood agar plates) . . .	0
Liquefaction of gelatin[1]	+
NH_3 production from peptone . . .	+
Reduction of nitrates	+
Hydrolysis of starch	0

[1]Time required for liquefaction, which varied considerably, is not stated in Hucker's report.

Fermentations[1]: glucose . . . . +
lactose . . . . +
sucrose . . . . +

In Table 1 these 136 strains are compared with respect to the remaining properties of pigmentation, reactions in litmus milk, and ability to utilize ammonium phosphate and/or asparagine as sole nitrogen source. It is interesting to note that according to the present edition of Bergey's Manual, the ammonium phosphate-negative strains would be identified as Micrococcus pyogenes var. aureus (orange), M. citeus (yellow) or M. pyogenes var. albus (white) provided litmus milk is acidified and curdled. There is no provision for the strains producing other reactions in milk, although most bacteriologists would probably class those producing insufficient acid to curdle, and perhaps those producing no change in milk, as varieties of the same three species. Among the ammonium phosphate-positive strains, those showing an acid proteolysis in milk would be classed as M. caseolyticus regardless of color, while those producing acid only, with no curd, would be M. conglomeratus (yellow) or gelatin-liquefying M. epidermidis (white). There appears to be no provision for the other ammonium phosphate-positive strains. The full complement of intermediate forms between the "saprophytic" M. caseolyticus and the three typically "parasitic" species is noteworthy.

A study of Table 1 reveals scarcely any exceptions to the generalization that for each color of pigment, and for each reaction in litmus milk, there are some strains which can utilize neither ammonium phosphate nor asparagine as sole nitrogen source, others which utilize asparagine only, and still others which can utilize both substances. The only combination which seems not to occur is ability to utilize ammonium phosphate coupled with failure to utilize asparagine. However, this is probably not a "missing link" in the sequence, but rather exactly what one should expect. Micrococci which require no organic nitrogen, but can form all amino acids, proteins, and other nitrogenous cell constituents from ammonium ions, must possess a variety of enzymes (deaminases, transaminases, etc) which can add

[1]Fermentation of glycerol and mannitol were also studied, but the results are not contained in the published report.

TABLE 1

Pigmentation, Reactions in Litmus Milk, and Utilization of Ammonium Phosphate and/or Asparagine by 136 Strains of Otherwise Similar Micrococci[1]. (Data from Hucker, 1924a).

	Utilization of Ammonium Phosphate and of Asparagine as Sole Source of Nitrogen							
$NH_4H_2PO_4$.....	0		0		+		+	
Asparagine.....	0		+		0		+	
	Color of colonies	No. of strains	Color of colonies	No. of strains	Color of colonies	No. of strains	Color of colonies	No. of strains
Reactions in Litmus Milk: Acid, Curdled, Peptonized	orange	10	orange	2	orange	—	orange	2
	yellow	4	yellow	*	yellow	—	yellow	6
	white	19	white	2	white	—	white	2
Acid, Curdled	orange	22	orange	ƒ	orange	—	orange	—
	yellow	11	yellow	1	yellow	—	yellow	6
	white	19	white	5	white	—	white	1
Acid Only	orange	2	orange	1	orange	—	orange	*
	yellow	2	yellow	—	yellow	—	yellow	4
	white	6	white	—	white	—	white	1
No Change	orange	1	orange	#	orange	—	orange	—
	yellow	—	yellow	—	yellow	—	yellow	2
	white	—	white	—	white	—	white	—

* This space could be filled by a non-sucrose-fermenting strain.
ƒ This space could be filled by a hemolytic strain.
\# This space could be filled by a starch-hydrolyzing strain.

[1] The 136 strains all share the following properties in common: cocci, 0.5-1.0 μ in diameter, with a tendency to occur in irregular clusters, non-sporeforming and non-motile; indole not produced, blood not hemolyzed, starch not hydrolyzed; gelatin liquefied, ammonia produced from peptone, nitrates reduced to nitrites, and glucose, lactose, and sucrose all fermented.

amino groups to carbon chains, remove them for transfer to other molecules, and the like. Doubtless some of these enzymes could remove amino groups from asparagine for transfer to other substances. Thus one would expect strains capable of utilizing ammonium phosphate to be able also to utilize asparagine.

Other strains of the micrococci have lost the ability to synthesize one or more of the amino acids, and consequently cannot grow with ammonium ions as sole nitrogen source. In those few instances where the amino acid which cannot be synthesized is aspartic acid (or an acid which can be formed from aspartic), asparagine will serve as nitrogen source; but with strains unable to synthesize any other amino acid, neither ammonium phosphate nor asparagine can satisfy the deficiency.

With respect to utilization of ammonium phosphate or asparagine, as with the other properties previously considered by Rahn (1929a), the micrococci are extremely variable and appear to form a continuous series including every conceivable combination of characters, and with no gaps which might be utilized for lines of demarcation between species or genera. Separation of genera on the basis of these characters is no more justified at the present time than the old separation based on pigment and habitat. It would only lead to the placing in different genera of otherwise identical organisms.

While utilization of ammonium phosphate coupled with failure to utilize asparagine does not occur a single time among the 136 strains considered in Table 1, this combination is recorded for 11 strains among the 316 used in Hucker's study. Whether these 11 instances represent extremely unusual occurrences, or whether they result from errors in testing or recording results cannot be determined with certainty. That typographical errors can scarcely be avoided in such long and complicated tables as Hucker used is indicated by the fact that four strains are recorded in the tables as producing indole, while the text clearly states that not one of the 316 strains produced indole when tested by four different methods.

At any rate, these 11 instances do not invalidate the argument that organisms utilizing ammonium ions should ordinarily be able to utilize asparagine also, or that the 136 strains of Table 1 show a continuous gradation of synthetic ability. Interesting in this connection is the observation of

Gladstone (1937) that on primary isolation from suppurative processes, Staphylococcus aureus commonly requires a number of amino acids, but on continual subculture on the usual laboratory media, such nutritive requirements become progressively simpler, until eventually growth can be obtained in inorganic synthetic media containing an ammonium salt and organic carbon. This would seem to indicate that the loss of ability to synthesize one or more amino acids, as postulated above, need not be a complete loss. Rather, the parasitic habitat tends to favor the proliferation of those cells able to utilize most rapidly the preformed amino acids found in the host tissues, while transfer to media lacking amino acids favors the multiplication of the cells capable of most rapid synthesis starting from ammonia.

While the mass-forming cocci are extremely variable with respect to the characters now used in their classification, it is, of course, possible that some more stable criterion may yet be discovered upon which a valid separation could be based. For some time, the ability to coagulate oxalated or citrated plasma has been used successfully as an indication of pathogenicity, and Evans (1948) has shown a high degree of correlation between coagulase production and anaerobic fermentation of mannitol; also between coagulase production and absence of a nutritional requirement for biotin. The difficulties here, as might be expected from the known variability of the group, are that some few of the coagulase negative strains also ferment mannitol anaerobically, and some appear to grow slowly without biotin. Further exploration of these possibilities is indicated, but at best they are likely to prove to be differences between species rather than genera.

It is concluded that on the basis of information now available, the micrococci cannot be considered as constituting more than one genus. Whether this genus should be called Micrococcus or Staphylococcus is debatable, although Micrococcus Cohn 1872 clearly has priority and would appear to be the name of choice provided only that a suitable culture can be found to conform to the description of the type species, Micrococcus luteus (Schroeter) Cohn. In this connection it may be noted that the strain designated as American Type Culture Collection No. 398 cannot serve as type culture if (as stated by Gibson, 1953) it fails to grow in Schroeter's tartrate-NH_3-salts medium. There is a considerable differ-

ence between the ability of an organism to utilize ammonium tartrate as sole source of nitrogen, carbon, and energy, and the ability to grow in ammonium tartrate media only when supplied with an additional source of carbon and energy. A.T.C.C. No. 398 appears to fall within the latter category (Breed, as cited by the Editorial Board, 1954).

SUMMARY AND CONCLUSIONS

1. Previous workers have shown that on the basis of the characteristics now used in their classification, the organisms of the micrococcus-staphylococcus group cannot be separated into species (or genera) except in a purely arbitrary and artificial manner.

2. A reappraisal of the only available study giving complete results for all strains shows that with respect ot utilization of ammonium phosphate and asparagine as sole nitrogen sources, these organisms constitute a continuous series which includes every conceivable combination of characters, and shows no gaps which might be utilized for lines of demarcation between species or genera.

3. It is concluded that separation of the genera Micrococcus and Staphylococcus at the present time is unwise.

4. Micrococcus Cohn 1872 would be the correct generic name for these organisms provided only that a type culture can be found which conforms to the original description of the type species, Micrococcus luteus (Schroeter) Cohn.

5. The strain designated as American Type Culture Collection No. 398 cannot serve as type culture if it fails to grow in media containing ammonium tartrate as the sole source of nitrogen, carbon, and energy.

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COMMENTS CONCERNING THE TAXONOMY OF THE GENERA MICROCOCCUS AND STAPHYLOCOCCUS[1]

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The Editorial Board of this Bulletin (1954) has summarized concisely the current status of the generic names Micrococcus and Staphylococcus, and has asked for comments and suggestions.

The first question raised is whether Micrococcus luteus (Schroeter) Cohn is a recognizable species. Breed (1952) has reviewed the literature and indicates that this species should be defined as non-liquefying, non-nitrate reducing, yellow-pigmented coccus capable of utilizing ammoniacal nitrogen as a sole source of nitrogen. He also suggests that ATCC culture 398 would make a satisfactory type culture. Gibson (1953) rejects the validity of this species because the suggested type strain does not grow in an ammonium tartrate-salts medium.

We have studied recently ATCC culture 398, in addition to a collection of named strains of micrococci, kindly supplied by Dr. Breed. In confirmation with Dr. Gibson's claim, strain 398 failed to grow in Cohn's ammonium tartrate medium or on Hucker's ammonium phosphate-glucose medium. Nine of the strains in the collection were reported to have grown in such media when first isolated, but at the present time only 2 of these 9 strains retained this characteristic. Further investigation revealed that the cultures failed to grow because of their inability to utilize tartrate or glucose as an energy source. Our present knowledge of the nutrition of these organisms also indicates that these tests are dependent upon carrying over the required vitamins in the inoculum. Therefore, we consider such tests for ammonia utilization inapplicable to this group of organisms.

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[1]Journal paper No. 113, American Meat Institute Foundation.

In spite of these findings, we do not feel that the species Micrococcus luteus should be invalidated or strain 398 rejected as the type culture. We feel that the species should be defined without reference to utilizable sources of nitrogen. Strain 398 is at the present time an obligate aerobic organism that obtains its energy from oxidation of the nitrogenous components of complex media. Although Hucker (1928) indicates that Micrococcus luteus strains produce acid from glucose and mannitol, these tests were performed by incubating agar slope cultures for as long as 30 days. He considered these "fermentation tests" to be of little value because the results were so frequently altered by changes in the nature of the inoculum, the composition of the basal medium, and the conditions of incubation (Hucker, 1924). Our present knowledge of microbial physiology and nutrition may enable us to eliminate these variations by limiting the term "fermentation" to the anaerobic utilization of a substrate as an energy source in a standardized basal medium.

We are also convinced that the coagulase-positive staphylococci represent one of the most homogeneous species of bacteria to be found in any genus (Evans, 1948; Evans and Niven, 1950). Our contention is supported by the studies of numerous earlier investigators and by the more recent studies of Shaw, Stitt, and Cowan (1951). We feel that this should be recognized as the type species of the genus Staphylococcus. There seems to be a reasonable doubt as to whether the correct specific epithet should be aureus or pyogenes. In view of the fact that orange strains frequently give off white variants and these variants, as well as naturally-occurring white strains, are otherwise indistinguishable from orange strains, we feel that the specific epithet pyogenes should be accepted.

If we recognize the validity of these two species, the next major problem is to decide whether they should be placed in the same genus or in separate genera. If they are to be placed in separate genera, we are then faced with the problem of where to draw the line of separation between the two genera.

We feel that such a separation is both desirable and possible, and therefore it is proposed that the separation be based primarily on the relation to oxygen of these organisms when growing in a standardized complex medium containing glucose. Those species which are facultative would then be

placed in the genus Staphylococcus and those species which are obligate aerobes would be assigned to the genus Micrococcus. To a limited extent the results would depend upon the constituents of the basal medium employed. For example, it has long been known that Staphylococcus pyogenes can grow aerobically but not anaerobically in a "synthetic" medium in the absence of uracil (Richardson, 1936).

It is interesting to note that Hucker (1924) stated, "the mass-forming cocci appear to form a group midway between the obligate aerobes and the anaerobes, and being such a transition group in respect to oxygen requirements, it is not unlikely that such a character will be found suitable for classification." However, he found no correlation between oxygen-requirements and sugar fermentations. This lack of correlation may well have been due to the methods employed. Oxygen requirements were determined by observing the nature of the growth in an agar stab culture and sugar fermentations were determined by observing acid production on agar slope cultures. It is probable that the use of agar shake cultures, or a comparison of aerobic and anaerobic growth in a broth medium, would show that many strains that Hucker designated as facultative are actually aerobic and many designated as microaerophilic are truly facultative.

Shaw, Stitt, and Cowan (1951) have proposed grouping the micrococci based upon acid production from glucose. Their failure to differentiate between fermentation and respiration may result in a less clear cut separation. Many of these organisms produce considerable ammonia from the nitrogenous constituents of the medium under aerobic conditions, thus tending to mask acid produced from the glucose. Examples are illustrated in Table 1. Only 4 of these strains are capable of true glucose fermentation. Some strains (e.g. 399) produce much acid aerobically although they are unable to metabolize glucose anaerobically. Strains such as 412 and 416 represent intermediate types. It is interesting to note that Shaw et al. studied most of these same strains and placed those that fermented glucose in their Subgroups 1 and 2, those which produced considerable acid aerobically but none anaerobically in Subgroup 3, and those which produced little or no acid aerobically in Subgroups 3 and 5. However, it is most doubtful that such a good correlation would exist if such a comparison were extended to more strains in Subgroups 1-4.

Table 1

Glucose fermentation and respiration by a collection of named strains of micrococci

Name	ATCC number	Final pH in Broth culture			Subgroup of Shaw et. al.
		Basal* (aerobic)	Glucose* (aerobic)	Glucose** (anaerobic)	
M. epidermis	155	7.9	5.3	5.1	2
M. rhodochrous	184	8.8	8.6	6.8	
M. rubens	186	8.5	6.9	6.8	4
M. citreus	395	8.9	8.7	6.8	
M. luteus	398	8.7	8.7	6.7	5
M. varians	399	8.9	5.0	6.6	3
M. flavus	400	8.4	7.7	6.6	5
M. conglomeratus	401	8.9	4.9	6.5	3
M. freudenreichii	407	8.5	8.4	6.5	5
M. ureae	408	8.4	8.2	6.7	5
M. roseus	412	9.0	7.1	6.6	4
M. roseus	416	8.8	7.6	6.7	4
M. denitrificans(L-450)		8.9	8.8	6.7	
M. agilis	998	8.9	7.5	6.8	5
M. lysodeikticus	4698	8.5	7.8	6.8	5
M. candidus	8425	7.4	4.6	4.3	
M. candicans	8456	8.2	7.9	6.8	5
M. caseolyticus	8460	8.0	5.0	5.0	1
M. progenes (85320)		8.2	5.6	5.0	
Uninoculated control		7.1	6.9	6.8	

* The basal medium contained 1.0 per cent trypticase (BBL) and 0.5 per cent yeast extract (Difco). Ten ml of medium per 50-ml Erlenmeyer flask were inoculated and incubated for 10 days at 20C.

** The medium for this series contained 1.0 per cent trypticase (BBL), 0.5 per cent yeast extract (Difco), 1.0 per cent glucose, 0.5 per cent NaCl, and 0.4 per cent K_2HPO_4. Five-ml amounts in 16 mm test tubes were inoculated, covered with sterile vaspar, and incubated for 10 days at 20 C.

To maintain the stability of these characteristics it would be advisable to carry stock cultures in media containing glucose. The obligate aerobes should be cultured on agar slopes or in shallow layers of broth, and the facultative organisms in ordinary tubes of broth media.

The taxonomy of these genera would best be served by defining valid species only on the basis of combinations of characteristics that occur with considerable frequency in strains isolated from different sources. This policy has fortunately been adhered to by most workers with this group of microorganisms. One should certainly refrain from establishing new species based on the study of only one or two strains, no matter how unique their characteristics may be. We also agree with Shaw et al. that it does not seem advisable to place strains that tend to form tetrads or regular packets into separate genera. They may represent distinct species within the genera Micrococcus and Staphylococcus.

CONCLUSIONS

Micrococcus luteus (Schroeter) Cohn is a recognizable species and ATCC culture 398 appears to be a satisfactory type culture. The ability to utilize ammoniacal nitrogen as a sole source of nitrogen is not a test applicable to this group of organisms because it cannot be studied independently of the energy metabolism and nutritional requirements for growth. The genera Micrococcus and Staphylococcus can be separated logically on the basis of their relation to oxygen in a standardized complex medium containing glucose. The former are obligate aerobes and the latter are facultative. Staphylococcus pyogenes is an extremely homogeneous species and the type culture suggested by Cowan, Shaw, and Williams (1954) appears quite satisfactory.

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THE CLASSIFICATION OF THE PLEUROPNEUMONIA GROUP OF ORGANISMS (BORRELOMYCETALES)

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The general properties of the organisms of the pleuropneumonia group (pleuropneumonia and pleuropneumonia-like organisms (PPLO)) may be summarized as follows:

1. Grow in cell-free culture media. Exacting nutritional requirements for most of the species.
2. A peculiar mode of reproduction characterized by breaking up of filaments (with more or less pronounced tendency to true branching) into coccoid elementary bodies.
3. A marked tendency to pleomorphism depending on cultural conditions.
4. A characteristic appearance of the minute colonies on solid media.
5. Filterability of the smaller reproductive units.
6. Poor affinity for the ordinary bacterial stains.
7. A high resistance to penicillin and sulfathiazole.

Nutritional requirements. With the exception of the saprophytic species, Mycoplasma laidlawii, all other species require enrichment with serum or ascitic fluid for growth on artificial media. Both protein and lipid components appear to be necessary (Edward and Fitzgerald (1951), Edward (1953), Smith and Morton (1951, 1953)). The ability of rabbit serum agar (low concentration of cholesterol) to support a poor or good growth can be used as a mark of differentiation between different species (Edward, 1954). The addition of a filtrate of a staphylococcal culture or fresh extract in a small concentration has been found to improve the growth of some strains (Edward, 1947). Desoxyribonucleic acid appears to be necessary for certain strains, at least at their first isolation (Edward, 1954).

Morphology. It has proved difficult to interpret properly the significance of the morphological details and the mode of growth of these organisms. The morphology of the type species, the organism of bovine pleuropneumonia (Mycoplasma mycoides), has been studied most thoroughly by various techniques. In fluid as well as on solid media the minute elementary bodies extrude one or more filaments of considerable length that ramify and form an apparently unicellular,

branching mycelium. At a later stage of growth tiny endomycelial corpuscles develop in the filaments by a process of successive condensation and constriction, no preceding formation of septa being demonstrable. As a result, the homogeneous filaments are transformed into chains of close-set spherical bodies. New free elementary bodies are released by fragmentation of these chains. The essentials of this mode of development and multiplication were described with various modifications by Ørskov (1927), Nowak (1929), Hosakawa and Kawamura (1931), Wroblewski (1931), Ledingham (1933), Klieneberger (1934), Tang et al. (1935), Turner et al (1935), and Freundt (1953).

The elements of the pleuropneumonia organism are extremely plastic and under certain growth conditions develop into peculiar forms, among which are the so-called "large bodies", often containing granules that have been a subject of special interest. Some of the authors cited above, especially Turner and Wroblewski, also claim to have observed various deviating growth forms, including multiplication by simple budding. But above all, an important role in the life cycle of the organism was ascribed to the "large bodies" by Klieneberger and Smiles (1943), Dienes (1945), Dienes and Weinberger (1951), and Tulasne (1951). According to these authors, minute granules multiply within the large bodies and after rupture of the surrounding membrane start the "life cycle" again as free elementary bodies. The long filaments are considered by Klieneberger and Smiles mainly as artefacts. On the other hand, Ørskov (1938) and Freundt (1952) regard the "large bodies" as representing a stage of involution and degradation. Experimental support to this concept was given by Freundt.

In the opinion of the author, the mycelial mode of growth and multiplication by development of endomycelial bodies as described for the type species should be regarded as fundamental morphological criteria of the group as a whole. The description merely of very pleomorphic elements consisting of granules, globules, rings, and filaments, does not appear to be sufficient for the morphological identification of pleuropneumonia-like organisms.

Branching filamentous forms breaking up into new elementary bodies were also described in the following species or strains: in Mycoplasma agalactiae by Wroblewski, by Ledingham and by Ørskov; in M. arthritidis (L4) by Preston;

in Asterococcus canis Shoetensack, M. pulmonis (L3), and M. laidlawii by Ørskov, and in strains from human sources by Beveridge and by Freundt. The above authors will agree that except for the smaller size of the filaments the morphology of these species is essentially similar to that of the bovine pleuropneumonia organism. On the other hand, Dienes (1953) and Morton et al. (1954) were not able to demonstrate anything but free elementary bodies in electron micrographs of PPLO isolated from man and poultry. Elementary bodies and small rod-shaped and filamentous forms were demonstrated by Klieneberger-Nobel and Cuckow (1955) in M. agalactiae, M. mycoides var. capri, and M. pulmonis.

Available representatives of most of the various species were investigated by the present author. Branching filaments could be demonstrated as a constant feature in all species, though the frequency of branching was admittedly low in some organisms. On the whole, each species could be classified within one of three morphological groups. Morphological differences between various strains belonging to one species may possibly occur, but in cases where the observation included more than one strain of each species these differences were of minor importance only. The organisms of Group I are characterized by an unstable, sparsely branching mycelium with very short, almost bacillary filaments (usually 2-5 μ). Gradual transitions are found to the relatively stable mycelium of Group II with a moderate length of filaments (10-30 μ). Group III is distinguished by a quite regular, fully developed, richly branching mycelium with filaments attaining a length of 100 to 150 μ or even more.

Colonial morphology. The appearance of the minute colonies on solid medium is very characteristic: an opaque, granular, brown, or yellowish central area growing down into the agar, surrounded by a translucent, flat peripheral zone of variable size. Slight variations in the colonial morphology are found in various species and on different media.

A peculiar phenomenon was observed by Edward (1950, 1954) in plate cultures of certain species. Small black dots consisting of deposits of calcium and magnesium soaps are produced by these species beneath and around the colonies, together with a crinkled, greyish film of a more complex composition on the surface of the medium, especially on horse serum agar incubated for 6 days. Growth in fluid and semi-solid media is granular or smooth and fluffy.

Size. Ultrafiltration experiments indicate a particle diameter of the basic reproductive units, the elementary bodies, of 125-150 mμ, i.e., the same order of size as that of the viruses of herpes simplex and vaccinia.

Staining properties. The organisms are Gram-negative. They stain poorly with ordinary bacterial stains, but fairly well with Giemsa.

Classification and Nomenclature

No general agreement has as yet been obtained as to the nomenclature and classification of the pleuropneumonia group. The variety of names suggested for the type species, the organism of bovine pleuropneumonia, reflects the confusion of nomenclature.

Ledingham (1933) emphasized the resemblance of the organisms of bovine pleuropneumonia and of agalactia to the actinomycetes and consequently proposed that these species be incorporated in the existing order Actinomycetales, family Actinomycetaceae. Undoubtedly there are conspicuous morphological similarities between the pleuropneumonia group and the actinomycetes. Thus the organism of bovine pleuropneumonia bears some resemblance to the actinomycetes within Ørskov's Group I, while the small-mycelial pleuropneumonia-like organisms may correspondingly be paralleled with the genus Nocardia (Ørskov's Groups IIa and IIb). However, these similarities do not necessarily suggest that a phylogenetic relationship exists between the two groups of organisms. The similarities may probably be interpreted only as an evidence of a parallel morphological differentiation within two large groups of mycelial microorganisms.

Turner (1935) erected a new order Borrelomycetales, with family Borrelomycetaceae and genus Borrelomyces.

The term Borrelomycetales was rejected by Sabin (1941) since Bordet and not Borrel was the first to describe the morphology of the pleuropneumonia organism. Sabin proposed a new class, Paramycetes, order Paramycetales or Anulomycetales, family Parasitaceae or Anulomycetaceae. A sub-grouping into genera and species referring to the animal host of the various organisms was also drawn up by this author. Recently Tulasne and Brisou (1935) proposed the ordinal name Pleuropneumoniales.

Clearly contrasting with the above attempts for a classification, Dienes in the last edition of Bergey's Manual suggested a close relationship with the species included in the genera Pasteurella and Haemophilus, thus adhering to the classification of Buchanan (1918). This classification appears to be inconsistent with the true mycelial nature - also admitted by Dienes - of the type species of the group, the organism of bovine pleuropneumonia.

Much confusion has arisen from an incorporation in the pleuropneumonia group of the so-called L-forms isolated from various bacterial cultures (e.g. the L_1 colonies isolated by Klieneberger from Streptobacillus moniliformis), especially under the influence of penicillin. Though it was stated by Dienes (Bergey, 1948) that these are "variant forms of the bacteria and should be classified with the parent organisms," Dienes and Weinberger later (1951) stressed the similarities between the pleuropneumonia organisms and the L-type variants, being inclined to regard the pleuropneumonia organisms as originally descended from ordinary bacteria. The same theory was advanced by Tulasne (1951). However, there appears now to be a growing feeling that the L-phase variants should be separated from any connection with the pleuropneumonia group (Edward, 1954).

Name of the Order and Family. Turner (1935) was the first to suggest a new order for the pleuropneumonia group of organisms. His name for this order, Borrelomycetales, and the family name, Borrelomycetaceae, therefore clearly have priority, and appear to be in accordance with Rule 1 of the International Bacteriological Code of Nomenclature. Some may argue that these names are unfortunate because they allude to a morphological character ("mycelial") which has not so far been generally accepted. It if be preferred to propose a new ordinal name based on an outstanding morphological property which all workers agree upon the name Molliparietales (lat. mollis soft + lat. parietalis wall) proposed by H.E. Morton in a personal communication to the author deserves consideration. Another possibility would be to derive the order and family name from the generic name to be proposed in the following: Mycoplasmatales, Mycoplasmataceae (cf. the second alternative of Rule 1).

Name of the Genus. As far as it appears from our present knowledge there is hardly any valid basis for the erection of more than one genus within the family. Any generic sub-

division founded on morphological and biochemical characters etc., would probably be rather arbitrary and the more so as there is no obvious constant correlation between these properties.

The status of the various generic names that have been applied to the type species has been fully summarized by the Editorial Board (this BULLETIN 5:13-20. 1955). It appears from this that Asterococcus Borrel et al. (1910) is illegitimate because it is a later homonym of the algal genus Asterococcus Scherffel (1908). Coccobacillus Martzinovski (1911) ted by Ørskov (1938) and Freundt (1952) is also invalid because it was used in 1888 by Dangeard for a fungus and in 1891 by Grüber for an organism which was later placed in the genus Actinomyces. The first name that is valid is Mycoplasma Nowak (1929) which is set up by the Editorial Board as an alternative to Borrelomyces Turner (1935).

The Editorial Board suggested that Borrelomyces might perhaps be preferred to Mycoplasma on the assumption that Borrelomyces is the only generic name that has been proposed to replace Asterococcus "which has found any general acceptance". This supposition, however, will hardly appear to be quite correct. In fact, as far as I can see, none of the generic names proposed to replace the illegitimate Asterococcus, including Borrelomyces, has ever found any general usage by bacteriologists. Therefore, though the present author originally felt inclined to conserve Borrelomyces there is scarcely any real justification to prefer this name to one which has priority. The conservation of Mycoplasma is formally correct and hence unimpeachable and less liable to meet with criticism. The possible objection by some workers that the syllable myco- involves an allusion to a disputed morphological character can in this connection be refuted with a reference to Rule 23 of the International Bacteriological Code of Nomenclature: "A name or epithet must not be rejected, changed or modified merely because it is badly chosen or disagreeable or because another is preferable or better known".

The following tentative list of species is proposed for the pleuropneumonia group. Two new species (Nos. 2 and 10) are described and named.

Order Mycoplasmatales ordo nov.
Genus Mycoplasma Nowak 1929.
Species 1. Mycoplasma mycoides (Borrel et al.) comb. nov. (Asterococcus mycoides Borrel, Dujardin-Beaumetz, Jeantet and Jouan 1910).
Subspecies 1. Mycoplasma mycoides var. mycoides comb. nov.
Subspecies 2. Mycoplasma mycoides var. capri comb. nov. (Asterococcus mycoides var. capri Edward 1953)
Species 2. Mycoplasma bovigenitalium sp. nov.
Species 3. Mycoplasma agalactiae (Wroblewski 1931) comb. nov. (Anulomyces agalaxiae Wroblewski 1931)
Species 4. Mycoplasma spumans Edward 1955.
Species 5. Mycoplasma canis Edward 1955 (not Asterococcus canis Shoetensack 1934).
Species 6. Mycoplasma maculosum Edward 1955.
Species 7. Mycoplasma pulmonis (Sabin 1941) comb. nov. (Murimyces pulmonis Sabin 1941).
Species 8. Mycoplasma arthritidis (Sabin 1941) comb. nov. (Murimyces arthritidis Sabin 1941).
Species 9. Mycoplasma neurolyticum (Sabin 1941) comb. nov. (Musculomyces neurolyticus Sabin 1941).
Species 10. Mycoplasma gallinarum sp. nov.
Species 11. Mycoplasma hominis Edward 1955 (in part Micromyces hominis Freundt 1954).
Species 12. Mycoplasma fermentans Edward 1955.
Species 13. Mycoplasma salivarium Edward 1955.
Species 14. Mycoplasma laidlawii (Sabin 1941) comb. nov. (Sapromyces laidlawii Sabin 1941).

Certain groups of strains of PPLO described in the literature undoubtedly deserve rank of species, but have from various causes not been listed above. Asterococcus canis Shoetensack I and II cannot from Shoetensack's descriptions be identified with any of the dog strains isolated in recent years, and the original strains are lost. Good descriptions were published of Musculomyces arthrotropicus and Musculomyces histotropicus Sabin (1941). But though very likely they really are independent species, the relationship to the species isolated from mice and rats by the English workers and based on still existing strains, still seems obscure. Sabin's strains are lost, but sufficient quantities of antisera for comparison and possible identification with other mice

strains still exist (Sabin, personal communication). But until this work has been done it will probably be more wise to make some reservations.

Pleuropneumonia-like organisms isolated in recent years from different sources, e.g. from swine (Carter and McKay 1953, 1954), from bronchopneumonia of cattle (Carter 1954) and from the eyes of a chameleon (Klinge 1954) need further study before they can be named as independent species.

Comments: The above list of proposed species in part results from informal discussions between Dr. D.G.ff. Edward and the author. A similar, but not quite identical list, is published by Edward in this BULLETIN (5:85-93. 1955). While the present author originally intended to set up one species for the organisms isolated from dogs, and one for those isolated from humans, each covering three or four types respectively, Edward – with one exception probably more correctly – proposed and named three species for each of them (from dogs: Nos. 4, 5, 6; from humans: Nos. 11, 12, 13). In the opinion of the present author the two groups of organisms isolated from dogs, named M. spumans and M. canis, should be included in only one species (M. canis) covering two types or subspecies, as the properties that separate them seem to be relatively insignificant and partly variable. However, in order not to create undue confusion Edward's nomenclature for the dog strains also on this point has been followed here.

The following two species are described and newly named.

Borrelomyces bovigenitalium nov. sp.

(P strains of the bovine genital tract, Edward)

Etym. bo.vi.ge.ni.tá lium. L. noun bos, bovis the ox; L. pl. n. genitalia the genitalia; M.L. adj. bovigenitalium of bovine genitalia.

Unstable, sparsely branching mycelium with very short, almost bacillary filaments which usually measure 2 to 5 microns in length. Gram-negative.

Horse serum agar: A film and spots are produced.
Horse blood agar: Alpha hemolysis.
Rabbit serum agar: Poor growth.
Semi-solid media: Fluffy growth throughout.
Broth: Dense, uniform opalescence.

Carbohydrates not attacked.
Methylene blue is reduced.

Ten strains investigated serologically shared common antigens, but at least three different serological types appear to exist.

Pathogenicity: Suggested as a cause of inflammation of the genital tract, predisposing to infertility, although inoculation of cultures into the uteri of heifers has so far been unsuccessful.

Source: Isolated from the bovine genital tract.

Habitat: Frequent inhabitant of the bovine lower genital tract, both in males and females.

Borrelomyces gallinarum nov. sp.

Etym. gal.li.nā rum. L. fem. n. gallina a hen; L. fem. gen. pl. n. gallinarum of hens.

Description taken from Edward (1954, pp. 52, 53).

Horse serum agar: A film and spots are produced.
Horse blood agar: Hemolysis.
Rabbit serum agar: Good growth.
Semi-solid media: Smooth growth throughout.
No acid from glucose.
Aerobic, facultative.

Pathogenicity: Does not produce lesions after experimental inoculation.

Comments: Herick and Eaton (1945) isolated a pleuropneumonia-like organism as a contaminant of a pneumonia virus which was being passaged in chick embryos. Report of pleuropneumonia-like organisms from egg-passage material containing microscopically visible agents which were regarded as viruses and which caused upper respiratory catarrh in fowls and turkey sinusitis was made by Markham and Wong (1953); following a series of thirteen successive subcultures in artificial media, the organisms produced specific lesions in embryonated eggs. Further work is needed before the significance of these pleuropneumonia-like organisms and their relationships to the viruses associated with these infections and the coccobacillary bodies of fowl coryza (Nelson 1935, 1937, 1940) can be determined.

Relationships to the L-phase of bacteria: Reversion of cultures of so-called pleuropneumonia-like organisms from chronic respiratory disease and turkey sinusitis to an organ-

ism resembling Haemophilus gallinarum has been reported by McKay and Taylor (1954); the significance of this finding cannot be evaluated as yet.

Source: Isolated from the upper respiratory tract of a fowl.

Habitat: From the normal and diseased upper respiratory tracts of fowls; presumed to be the etiological agent of chronic respiratory diseases of chickens and of sinusitis of turkeys although this has not been proven experimentally.

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REPORT ON A QUESTIONNAIRE CONCERNING VIRUS NOMENCLATURE

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The Virus Subcommittee of the International Nomenclature Committee has made proposals for a "non-Linnaean binomial" system for naming viruses, at any rate as a temporary expedient: These proposals have been described in this Bulletin (Subcommittee, 1954) and elsewhere (Andrewes, 1954). They include the use of the suffix "-virus" for names of groups of animal-, but not necessarily plant-viruses.

It was suggested to the writer that it would be expedient to obtain expressions of opinion from a wide range of virologists as to the value of the "Rome proposals". The questionnaire described below was therefore sent out to 120 workers. Two animal virologists holding divergent views (Dr. Geoffrey Rake and the writer) each provided lists of about thirty animal virologists; and on a similar basis two lists each of about thirty plant virologists were supplied by Dr. C.W. Bennett and Mr. F.C. Bawden. The four people suggesting names were asked to make their lists as representative as possible both on a geographical basis and on the basis of the known or suspected opinions of the people concerned. It is hoped that the 120 people ultimately canvassed may be considered truly representative: they were from 22 different countries. Sixty-six of them were animal virologists and only 54 plant virologists; however, replies came from almost equal numbers of animal (36) and plant (39) virologists.

(i) Fifty-seven of 66 replies favoured an attempt to reach a compromise between diverging views on virus nomenclature.

(ii) Sixty favoured attempts on an international basis to agree on a common plan for naming viruses: 12 preferred a policy of laissez-faire, allowing the subject to develop in its own way.

(iii) Fifty-one favoured "attempts to deal with all viruses along parallel lines, realizing that if this is done all

parties will have to make concessions to the views of others."

Sixteen preferred that "those studying viruses attacking vertebrates, insects, bacteria and higher plants should develop their own systems independently."

(iv) Forty-seven favoured the Rome proposals as a halfway solution or a compromise between opposing viewpoints. Ten preferred some other form of compromise and thirteen rejected compromise altogether. In this section of the questionnaire there was some divergence of view between the animal and plant virologists: 29 of 36 animal virologists favoured the Rome proposals while only 18 of 33 plant virologists did so. Six plant virologists 'abstained' having found it difficult to answer the question in the form in which it was presented.

(v) The recipients of the questionnaire were asked whether they favoured a Linnaean system (a) as soon as possible; (b) ultimately but not now; (c) now now, matter to be reviewed periodically; (d) not at all: also whether their reply was applicable to their own field of viruses or to all viruses. Nineteen (6 animal, 13 plant) favoured (a), 22 (14 animal, 8 plant) favoured (b), 37 (20 animal, 17 plant) preferred (c) and 8 (3 animal, 5 plant) were for (d) "never." A few of those replying did not distinguish between (b) and (c) and voted for both. Most said that their view applied to all viruses or else did not answer that part of the question.

Finally,

(vi) It was asked whether, if the virus supplement were dropped from the next edition of Bergey's Manual, the International Subcommittee should work towards something to replace it (a) along the lines of the Rome proposals, (b) otherwise. Forty-five favoured (a) and 21 (b). As with question (iv), the animal virologists favoured "Rome" by 26:7 while the plant virologists were more nearly evenly divided (19:14).

Altogether there has been less divergence of view, particularly as between animal and plant virologists, than might have been expected. Particularly impressive is the strong feeling, even greater among the plant pathologists, in favour of treating all viruses along parallel lines. In view of this feeling it seems to the writer that the most logical course is for all to adopt the Rome plan, which has the greatest measure of general support.

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THE STATUS OF THE GENERIC NAMES ARTHROBACTER FISCHER AND ARTHROBACTER CONN AND DIMMICK

Editorial Board

Preliminary Statement

The generic name Arthrobacter was proposed by Fischer (1) in 1895 to include all non-flaggellate rod-shaped bacteria which produce arthrospores. No species was named. Later this author (2) in 1903 abandoned the name. A careful search of the literature has revealed that no species has been named and placed in the genus Arthrobacter Fischer. Under Rule 24 of the Bacteriological Code a name must be rejected if it is illegitimate. A name is illegitimate if its application is uncertain (nomen dubium), and it may then be placed in the list of nomina rejicienda.

The validity of publication of the name Arthrobacter Fischer may also be challenged. Rule 12 of the Bacteriological Code requires that to be validly published a name must be "accompanied by a description of the group or by reference to a previously and effectively published description of it." The adequacy of a description of a genus which has no named species is certainly questionable. Validity of publication also requires that the name be accepted by the author, that it should not be a nomen provisiorium anticipating eventual acceptance. It is concluded that the name Arthrobacter Fischer was not validly published and hence is "without standing in nomenclature."

Arthrobacter was also proposed as a generic name by Conn and Dimmick (3) in 1947. They state that they desired "to revive by emendation, an old name, Arthrobacter Fischer (1895), which as originally proposed was a nomen nudum, as no species were named, and it was subsequently abandoned even by its author." The generic name was cited as "Arthrobacter Fischer, emend." A type species A. globiforme (Conn) Conn and Dimmick and two other species were described.

Several questions arise relative to Conn and Dimmick's "revival" of the generic name Arthrobacter Fischer.

1. Should Fischer be cited as the author of the generic name Arthrobacter as described by Conn and Dimmick? It is concluded above that the name was not validly pub-

lished, and is quite without standing in nomenclature. In other words, it never was a generic name that could be recognized or revived.

2. Was the generic name Arthrobacter validly published by Conn and Dimmick: The publication of the name meets all of the pertinent provisions of Section 3 of the Bacteriological Code.

3. Is the generic name Arthrobacter as proposed by Conn and Dimmick legitimate? A legitimate name is one that does not contravene a rule. This generic name is not a later homonym of any validly published earlier name of a genus of bacteria, of plants or protozoa. It meets the test of legitimacy.

4. How should the generic name be cited? As Arthrobacter Conn and Dimmick 1947.

Draft Proposals for Opinions

1. The bacterial generic name Arthrobacter Fischer 1895 was not validly published and has no standing in bacteriological nomenclature. It is placed in the list of nomina generum rejicienda.

2. The bacterial generic name Arthrobacter proposed by Conn and Dimmick (1947) was not an emendation of Arthrobacter Fischer. It was validly published as a nomen novum and should be cited as Arthrobacter Conn and Dimmick 1947.

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A SUGGESTED CLASSIFICATION AND NOMENCLATURE FOR ORGANISMS OF THE PLEUROPNEUMONIA GROUP

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Recently in reviewing the pleuropneumonia group of microorganisms the need for a nomenclature, agreeable to those working in this field, was stressed (1). However, the existence then of disagreement regarding the relationship of the organisms to bacteria, particularly to bacteria in the L phase, made an attempt at nomenclature seem premature. Freundt (2), Edward (1) and Klieneberger-Nobel (3) had pointed out differences between organisms of the pleuropneumonia group proper and the L phase of bacteria and classified them separately. Dienes and Weinberger (4) and Tulasne (5), on the other hand, suggested that the former might be derived from bacteria through the formation of persistent L phase variants. Tulasne and Brisou (6) have now suggested a classification and nomenclature in which pleuropneumonia-like organisms without a proven derivation from bacteria are placed in one new order Pleuropneumoniales and the L phase organisms are assigned to a second order Bactepneumoniales. Since these workers agree to grouping organisms of the pleuropneumonia group proper separately from the L phase organisms, it would seem useful to suggest a system of nomenclature for the former group that conforms to the International Bacteriological Code of Nomenclature. The position has moreover been further clarified by a preliminary statement published by the Editorial Board of the International Bulletin of Bacteriological Nomenclature and Taxonomy (7), regarding the validity and priority of names for the organisms of bovine pleuropneumonia.

An attempt to classify the pleuropneumonia group now may have the advantage of focussing attention on the organisms and of stimulating study. The settling up of named species may also encourage the detailed study of individual strains for purposes of identification. It is, therefore, proposed to suggest a provisional classification and nomenclature with particular reference to species which have been isolated and studied in this laboratory.

Principles

This classification is based on certain principles. Firstly, it is believed that the organisms of the pleuropneumonia group differ from both bacteria and viruses (1); they are thus assigned to a new order. In Bergey's Manual of Determinative Bacteriology (8) the orders Virales and Rickettsiales are placed as supplements to the classification of bacteria, since their relationships are uncertain. If this scheme is adopted the new order would be included as a third supplementary group.

A number of different organisms of the group have been described; some undoubtedly represent species, but the status of others is more questionable and it may be argued that they should rather be regarded as varieties or serological subtypes. There are no longer in existence strains of some of the species which have been described. Where the original description is inadequate it would seem unwise to include these species in the classification. Even when a species has been defined by as full an examination as is now possible it may be found that in the light of later knowledge such a definition was inadequate. It is thus desirable that for each named species there should be kept in collections of type cultures a representative strain upon which the properties of that species have been based.

Sabin (9) suggested grouping the species into genera according to the animal from which they were isolated. His system of classification and nomenclature has not been generally accepted in spite of subsequent revision (10). Any scheme of classification in which animal host alone determines the establishment of genera is open to objection; every property should be taken into account and particular attention paid to cultural and biochemical properties which form the basis for classifying bacteria. It may be noted that two species of pleuropneumonia-like organisms which have been isolated from cattle differ markedly from each other in their cultural properties. On the other hand, the differences in cultural properties between the organisms causing pleuropneumonia in cattle and goats respectively are negligible and provide no justification for placing the organisms in different genera.

If the pleuropneumonia-like organisms are to be classified into more than one genus, metabolic behavior would

seem to provide the soundest basis for distinguishing between the genera. However, since at present little is known of their metabolic processes it would seem wise to recognize only one genus. A case might be made for assigning the saprophytic strains to a second genus, but, although their normal habitat is outside the animal body and they can grow on media devoid of serum, this may not represent an absolute difference in growth requirements. The organism of goat pleuropneumonia can grow to some extent without serum.

A proposal to set up a new order to contain only one genus is open to obvious objection, but is regarded as being only provisional. In attempting to classify the organisms at this stage of our knowledge it would seem wisest to err on the side of simplicity, rather than to suggest a more complex scheme which might quickly be found to be undesirable in the light of further discoveries in this rapidly expanding field. New genera can be set up later and existing species assigned to them.

Type Species

The organism of bovine pleuropneumonia would seem the obvious choice as type species. It was the first to be isolated and has been studied the most. Moreover, it has already provided the name by which the organisms of the group have hitherto been known (pleuropneumonia-like organisms). The choice by Sabin (10) of the organism of agalactia as the type species was perhaps unfortunate; its cultural properties had not then been firmly established (1).

The Editorial Board of the International Bulletin of Bacteriological Nomenclature and Taxonomy (7) has recently published a preliminary statement regarding the validity and priority of names for these two organisms. Asterococcus mycoides was the first name given to the organism of bovine pleuropneumonia, (Borrel et al. 1910). The generic name is invalid as it had previously been used to name a genus of algae; the specific epithet remains valid. The first valid generic name given to the organism was Mycoplasma (Nowak, 1929). Subsequently, Wroblewski (1931) suggested Asteromyces for the organism of bovine pleuropneumonia and Anulomyces for the organism of agalactia. Borrelomyces (Turner, 1935) was a later synonym for the genus, the fourth in order of priority. The Editorial Board suggest two alternatives for naming the genus. The first proposal is to ac-

cept Mycoplasma since it was the first legitimate name proposed. The second is to accept Borrelomyces, as other names with priority over it have not found general usage.

If the rules of nomenclature are to be strictly observed there is no doubt that Mycoplasma is the legitimate name. It is true that it has not been generally used, but nor have the other generic names, with the exception of Asterococcus, now found to be invalid. Rule 23 of the Rules of Nomenclature specifically excludes rejection of a legitimate name "because it is inappropriate" or "because another is preferable or better known." There does not seem to be any justification for claiming an exception to this rule in the case of Borrelomyces, which has not been generally used in papers published by workers in this field, in spite if its occasional acceptance, and it would not appear to be a more appropriate name. All the names which might legitimately be considered are unfortunate because they suggest a relationship with the fungi. For Mycoplasma it may be claimed that it has the advantage of drawing attention to one generally accepted property of the organisms, namely, their plasticity.

Name for the Order

The suitability of the name of the order is probably more important than suitability of the generic name, as it is the former which is likely to provide the common name used for the whole group of organisms, distinguishing them from bacteria, viruses and other microorganisms. If the genus is to be named Borrelomyces, it would probably be necessary to accept Turner's (14) suggestion of Borrelomycetales for the order.

The amended Rules of Nomenclature state:-

"Rule 2. Names of all taxonomic groups (taxa) above the rank of family are taken preferably from a combination of characters covering the nature of the taxa as closely as possible, or from a single character of outstanding importance. Recommendation:- Names of orders and suborders may appropriately be based upon the name of a contained family." Thus it is not obligatory to base the name of the order on the name of the type genus; it is, in fact, preferable to base it on an outstanding character. If Mycoplasma is accepted as the legitimate name for the type genus, it is permissible to suggest a new name for the order. Microscopical exami-

nation of the organisms, including the use of the electron microscope, has shown that they lack a definite cell wall and are bounded only by a plastic membrane. This would seem to be an outstanding character and may be of fundamental importance in explaining some of their cultural and metabolic peculiarities. Mollicutales, based on this characteristic, is therefore suggested as a name for the order.

Tulasne and Brisou (1955) have suggested Pleuropneumoniales as a name for the order. It incorporates "pleuropneumonia" which has provisionally come into general use to provide a comprehensive term for the group, but it would perhaps be unfortunate if a name based on a disease rather than on the organism itself were perpetuated. The type species causes pleuropneumonia but other species do not. Although Pleuropneumoniales has priority over Mollicutales, it is desirable that workers in this specialized field should have some choice from among the suggestions which are now being made as a result of informal discussions between them. In this way it may be possible to arrive at a system of classification and nomenclature which is generally acceptable. The following classification is therefore offered as a suggestion for other workers.

Suggested Classification and Nomenclature

Order Mollicutales ordo nov. Includes all organisms of the pleuropneumonia group, as defined elsewhere (Edward, 1954).

Family Mycoplasmataceae fam. nov.

Genus Mycoplasma Nowak, 1929.

The type species is Mycoplasma mycoides.

Individual species

1. Mycoplasma mycoides (Borrel et al., 1910) comb. nov. Organism causing contagious pleuropneumonia of cattle. Representative strain:- N.C.T.C. No. 3278 (P G 1*).

*No. of culture in collection at the Wellcome Research Laboratories.

Mycoplasma mycoides var. capri (Edwards, 1954) comb. nov. Organism causing contagious pleuropneumonia and other infections in goats. Representative strain:- P G 3*.

2. Mycoplasma agalactiae (Wroblewski, 1931) comb. nov. Organism causing contagious agalactia. Representative strain:- P G 2*. Specific epithet was originally spelt agalaxiae, but agalactiae is preferable (7). Cultural properties described by Edward (1954).

3. Mycoplasma bovigenitale sp. nov. P strains from cattle (Edward, 1950). Representative strain:- P G 11*.

4. Mycoplasma spumans sp. nov. strains from dogs (Edward and Fitzgerald, 1951). Representative strain:- P G 13*.

5. Mycoplasma canis comb. nov. strains from dogs (Edward and Fitzgerald, 1951). Representative strain:- P G 14*. The specific epithet is that used by Shoetensack (1936), but it is no longer possible to determine whether the organism is the same as he isolated.

6. Mycoplasma maculosum sp. nov. strains from dogs (Edward and Fitzgerald, 1951). Representative strain:- P G 15*.

7. Mycoplasma hominis comb. nov. Type 1. Human type 1 strains (Edward, 1954). Representative strain:- P G 21*. , Type 2. Human type 2 strains (Edward, 1954). Representative strain:- P G 27*.

8. Mycoplasma fermentans sp. nov. Human type 3 strains (Edward, 1954), based on the cultural and biochemical examination of one strain (P G 18*) isolated by Ruiter and Wentholt (1952).

9. Mycoplasma salivarium sp. nov. Human type 4 strains (Edward, 1954). Representative strain:- P G 20*. Has

*No. of culture in collection at the Wellcome Research Laboratories.

not yet been compared with strains isolated in America, (Morton et al., 1951).

10. Mycoplasma neurolyticum (Sabin, 1941) comb. nov. Type A and L 5 strains from mice. Representative strain:- L 5 (P G 28*).

11. Mycoplasma arthritidis (Sabin, 1941) comb. nov. L 4 strains from rats. Representative strain:- "Preston" (P G 6*).

12. Mycoplasma pulmonis (Sabin, 1941) comb. nov. L 3 strains from rats (Klieneberger, 1938). Representative strain:- "Ash".

13. Mycoplasma laidlawi (Sabin, 1941) comb. nov. Sewage and other saprophytic strains. Representative strain:- Sewage A (Laidlawi and Elford, 1936), (P G 8*).

Other strains

a) From rats and mice. A large number of strains with different properties has been isolated from rats and mice. They appear to belong to different species, but one species, at least, has been found inhabiting both rats and mice. More work is required to examine and compare strains isolated in different laboratories. In the present state of our knowledge it is largely a matter of opinion how many species should be recognized and named, especially since strains of some of the species that have been described are no longer in existence, although specific antisera may still exist. In this classification three species, M. neurolyticum, M. arthritide and M. pulmonis, have been recognized, each based on the examination of a single existing strain.

b) From fowls and turkeys. Strains have been isolated from fowls and turkeys, particularly in association with infection of the upper respiratory tract, but until these strains have been compared with each other and their properties established it would seem premature to establish a named species.

*No. of culture in collection at the Wellcome Research Laboratories.

c) From other animals. Although pleuropneumonia-like organisms have been isolated from other animals, the strains have not yet been sufficiently described to deserve the status of named species.

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INTERNATIONAL BULLETIN OF BACTERIOLOGICAL NOMENCLATURE AND TAXONOMY
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NEWS AND NOTES

THE BULLETIN. Serious consideration is being given to the future of the BULLETIN. It has been urged that its name INTERNATIONAL BULLETIN OF BACTERIOLOGICAL NOMENCLATURE AND TAXONOMY is perhaps too restrictive. The suggestion has been made that a somewhat broader title might be advisable, perhaps a name such as "Systematic Microbiology" would more correctly define the scope of the journal. The BULLETIN should continue to assist through publication in the development of a satisfactory nomenclatural code, and in its interpretation through Opinions. But it is quite as much the purpose of the BULLETIN to publish papers having to do with all phases of microbial classification and relationships. Taxonomy may be historical and legalistic, the organization of the recorded knowledge of interrelationships and differences among the several categories of taxa. This is important. However, at present it is quite as important that there be published the results of laboratory experimental work which will use the many new criteria available to make clearer these resemblances and differences. Relationships, at least resemblances and differences, can be studied by a great variety of techniques, morphology, cytology, genetics, pathogenetics, physiology, biochemistry, biophysics, phage susceptibility, serology, and others. In general these have not been adequately explored and the resultant findings correlated, they can make highly significant additional contributions to classification and taxonomy of microorganisms. The Editorial Board recognizes the importance of the historical approach, particularly from the standpoint of nomenclature, and the elimination of nomenclatural confusion. But it also will welcome submission by authors of papers for publication in which there are experimental studies determining the criteria useful in distinguishing taxa. It is taxonomy that describes and delimits, nomenclature can then assist in correct application of names.

One of the real difficulties in taxonomy is that there are no well described, defined and definitely designated nomenclatural types. There is a lack of type or standard cultures, deposited and available in our several type culture collections. When once there has been agreement as to these types, it would then be possible to eliminate much nomenclatural confusion. The identification and adequate characterization of type cultures should not be left alone to the initiative of

the staffs of type culture collections. Papers in this field will be welcomed by the BULLETIN.

PROPOSAL FOR PUBLICATION OF DIAGNOSIS OF ALL NEW TAXA IN MYCOLOGY. Prof. G.C. Ainsworth of the Exeter and Prof. R. Ciferri of Pavia (Taxon 4:3-6. 1955) presented to the Section on General Mycology of the VIIIth International Botanical Congress, Paris, a proposal that there by exploration of "the possibilities for the establishment of a new International Review devoted to the publication of diagnoses of new mycological taxa". The resolution was adopted unanimously by the Section and considered by the "Commission des Voeux" with reference to its possible implications concerning general reform in taxonomic documentation. They make the following interesting observation: "While no one is anxious to introduce bureaucratic methods into taxonomy, anyone who proposes a new taxon has certain social obligations and it might eventually be desirable for the rules to require that a new name published in accordance with the prevailing code has to be validated by registration with a central authority which would at regular intervals issue lists of new taxa", and "Births, marriages and deaths have to be registered – why not new genera and species, new combinations, and new synonyms?" The authors state that about 50 new genera and between 600 and 700 new species of fungi are described annually.

It has been suggested that a similar service for those working with bacteria, related organisms and the viruses be undertaken by this BULLETIN, with quarterly or annual publication of the names of new species, new combinations, and names proposed for reduction to synonymy, with citation of original references. Whether republication of the diagnoses of new taxa would be advisable might be questioned. The numbers of names of taxa in bacteriology and virology is much smaller than in mycology. Would publication of such lists be helpful?

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